CHAPTER 7.3
METALS PRECIPITATION

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7.3-1. GENERAL. Precipitation is a technology used to remove toxic dissolved metal contaminants from ground water. In ground water treatment applications, the metal precipitation process is also used to remove non toxic metals (iron, calcium, and manganese) that could cause fouling and plugging of other treatment processes such as air stripping, carbon adsorption, and chemical oxidation. Metal precipitation converts dissolved heavy metal ions to insoluble salts that will precipitate (settle) out of the water. The precipitate is then removed from the treated water by physical methods such as clarification (settling) and filtration.

Precipitation is often performed in several tanks in series and consists of pH adjustment, coagulation, flocculation and settling. In the first tank, the pH is raised by the addition of a reagent such as lime or caustic. The water then flows to a second tank where the dissolved metals react with the reagent to form insoluble salts (coagulate). These insoluble salts combine into larger floc particles (flocculate). The water is then moved with low shear pumps or by gravity to a clarifier where the floc particles settle relatively quickly to the bottom of the tank. Additional chemicals are sometimes added to enhance the precipitation. In some designs, multiple operations identified above may be done in one tank. The resulting sludge in the bottom of the tank is then removed. Typically, the treated process water requires filtration to remove any traces of floc prior to the next treatment process. Often times, the sludge is further concentrated using a sludge thickening tank and a filter press. The thickened sludge is often a hazardous waste and must be disposed of in a RCRA hazardous waste treatment, storage, and disposal facility.

7.3-2. PRODUCTS

a. Equalization Tank. Ground water is often pumped directly into an equalization tank prior to treatment. The purpose of the equalization tank is to reduce variation in ground water characteristics such as flow rate and contaminant concentration. The equalization tank is usually cylindrical in shape and may be made of metal, plastic or concrete. The tank may have a mechanical mixer or air sparger to help keep the contents mixed. If the ground water contains volatiles, the tank may be covered and vented (using a blower) to an air pollution control device such as a carbon adsorber. The tank may also contain a mechanical device to remove sludge or it may need periodic manual cleaning.

b. pH Adjustment Tank. In many cases, ground water flows by gravity or is pumped from the equalization tank into a pH adjustment tank where the pH is raised, causing metals to become insoluble and precipitate. The most common chemicals used are lime and caustic. If lime is used, a lime slaker unit will be installed that mixes the dry lime with water and pumps it into the pH adjustment tank. If caustic is used it is pumped into the tank from a drum or caustic storage tank. Verify that pH adjustment tanks are accessible as lime or caustic supplies will need to be routinely replenished. Also, verify that the tank is made of the materials stated in the specifications. Automatic instruments measure the pH in the tank and control the rate of lime or caustic addition. The pH adjustment tank is kept mixed with a mechanical mixer.

c. Coagulation Tank. Ground water flows from the pH adjustment tank into a coagulation tank. This tank is equipped with a mechanical mixer which allows dissolved metals to react and form insoluble salts.

d. Flocculation Tank. Ground water flows from the coagulation tank into a flocculation tank. Here the insoluble metal salts form large insoluble particles called floc. Sometimes a chemical (typically a polymer) is pumped into the tank to help in the formation of floc. Floc is kept in suspension in the water by gently mixing with a mechanical mixer.

e. Clarifier Tank. Ground water flows from the flocculation tank to the clarifier tank. Here the floc settles and is removed. Clarifiers may be cylindrical or rectangular in shape and made from either metal or plastic. In other cases, a more complex clarifier unit with inclined plates may be specified. The unit may have a scraper on the bottom to remove the settled floc (sludge), a sloped bottom with a drain for removing the sludge, or a flat bottom that must be cleaned manually. Clarifier operation is usually controlled by weirs which must distribute flow evenly. It is also critical that the weir be set at the correct elevation to control the hydraulics.

f. Filter. A filter is used to remove any floc that does not settle out in the clarifier. The filter unit could be a low pressure or high pressure sand filter or a cartridge filter if the system is small. The solids filtered out are returned to the clarifier tank. A further discussion of filters is found in section 7.4.

g. Sludge Thickener. The sludge from the clarifier tank usually contains about two per cent solids. This sludge is pumped to a sludge thickener where it is allowed to consolidate to a concentration of about five per cent. Chemicals (polymers) are sometimes added to improve thickening (dewatering). A further discussion of sludge thickening is contained in section 7.8.

h. Sludge Filtration. The thickened sludge is further dewatered in a filter. Most often, the filter type is a plate and frame filter press, however, a vacuum belt filter is also occasionally used. The filtered material (filter cake) is generally a hazardous waste and must be disposed of off site in a RCRA hazardous waste landfill. Further discussion of sludge filtration is contained in section 7.8

7.3-3. EXECUTION.

a. Level Mounting Surface. For small, pre-fabricated units, an obvious concern is that a level surface is constructed for system mounting. This is especially important for clarifiers where each weir must be carefully leveled.

b. Construction Connections. Construction of the connection between the tank wall and the concrete floor of the treatment facility is critical in preventing leaks.

c. Access Port. If an access port is cut in a tank side to facilitate construction, the opening should have rounded corners to allow for ease of repair.

d. Finished Floor. If a scraper mechanism is used in the

bottom of a clarifier, the finished floor must be smooth enough to allow the scraper to operate properly. Normally this is accomplished through the placement of grout and use of the scraper mechanism in the clarifier to ensure a flat surface with acceptable tolerance. If the scraper mechanism is utilized to finish the floor, ensure that the squeegees are adequately cleaned following use.

e. Unit Clearance. If the top of the clarifier unit is placed near the ceiling, adequate clearance for the removal of the drive mechanism must be maintained. This may also be accomplished through the use of a sky light.

f. Appurtenances. All equipment and controls required to operate chemical precipitation units should be provided in easily accessible locations to facilitate system operation and maintenance. This includes items such as flow controls, level controls, pH probes, and ORP (Oxidation-Reduction Potential) probes.

g. Operation. Operation of the metals precipitation unit involves monitoring system performance. Metal precipitation units must be closely controlled. Small changes in pH (0.1 - 0.3 pH units) can significantly reduce the amount of metals that precipitate, potentially resulting in violation of discharge permit limits.

(1) Verify the operator addresses items such as even flow distribution, inadequate settling, insufficient or overdosing of chemicals, incorrect pH/ORP and effluent clarity.

(2) The operator should develop a sludge wasting schedule to remove settled solids from the metals precipitation clarifier.

(3) Look for potential problems with metals precipitation units such as algal blooms, poor floc formation, and poor settling characteristics. Algal blooms may be avoided by covering the unit to prevent exposure of the water to sunlight. Poor floc formation and poor settling characteristics may indicate improper chemical reagent use and/or dosages.

(4) Verify that the sludge cake conforms to the acceptance requirements of the disposal facility. High moisture content may cause the sludge to be rejected.

(5) Verify that the sludge is manifested correctly before being shipped off site. Correct manifesting can be complex. Refer to EP 200-1-2 for additional information on manifesting.